

**OPTICAL TECHNIQUES FOR MEASURING LAYER THICK-  
NESSES AND OTHER SURFACE CHARACTERISTICS  
OF OBJECTS SUCH AS SEMICONDUCTOR WAFERS**

**ABSTRACT OF THE DISCLOSURE**

A characteristic of a surface is measured by illuminating the surface with optical radiation over a wide angle and receiving radiation reflected from the surface over an angle that depends on the extend of the illumination angle. An emissivity measurement is made for the surface, and, alternatively, if a reflectivity measurement is made, it becomes more accurate. One application is to measure the thickness of a layer or layers, either a layer made of transparent material or a metal layer. A one or multiple wavelength technique allow very precise measurements of layer thickness. Noise from ambient radiation is minimized by modulating the radiation source at a frequency where such noise is a minimum or non-existent. The measurements may be made during processing of the surface in order to allow precise control of processing semiconductor wafers, flat panel displays, or other articles. A principal application is in situ monitoring of film thickness reduction by chemical-mechanical-polishing (CMP).